The performance of an OFDM system in accordance with the present invention was simulated. The simulated OFDM system includes 256 subcarriers (N=256), which are divided into 16 clusters (i.e., M= 16), each having 16 subcarriers. QPSK is used to modulate the tones. Performance is measured by the word error rate (WER), where word corresponds to one OFDM block or, equivalently, the length of one inversion sequence. Initially, results on the detection performance are based upon the probability that the inversion sequence is received in error.

FIG.7 shows the probability of error in detecting the inversion sequence as a function of the signal-to-noise ratio (SNR) in an additive, white, Gaussian noise (AWGN) environment. The simple cluster-by-cluster detection scheme requires the highest SNR for a desired WER. By using minimum distance decoding, whether based on Hamming or Euclidean distances, significant improvements are obtained. The benefit comes from the error correction that is possible with minimum distance decoding. The 16 Walsh sequences of length 16 have a minimum distance of 8 and, as such, can correct up to 4 errors. Using the Hamming (Euclidean) distance, a 1% WER can be achieved with an SNR of about 3.2 dB (2.3 dB).

The present invention provides an OFDM system that provides enhanced PAP statistics with minimal loss in efficiency. The system embeds combining or inversion sequence information without additional overhead. In addition, the embedded inversion sequence can be reliably detected by the receiver. Performance can be further improved by increasing the number of tones per cluster.

One skilled in the art will appreciate further features and advantages of the invention based on the above-described embodiments. Accordingly, the invention is not to be limited by what has been particularly shown and described, except as indicated by the appended claims. All publications and references cited herein are expressly incorporated herein by reference in their entirety.

What is claimed is:

1. A method for reducing the PAP ratio in an OFDM system, comprising:

dividing a data block into a plurality of clusters;

determining a respective phase factor for each of the plurality of clusters to form an inversion sequence for reducing the PAP ratio of transmitted data corresponding to the plurality of clusters; and

embedding the inversion sequence onto the transmitted data.

2. The method according to claim 1, further including rotating at least one tone in a first one of the plurality of clusters when the corresponding phase factor rotates the first one of the plurality of clusters.

3. The method according to claim 2, further including rotating every other tone in the first one of the plurality of clusters.

4. The method according to claim 1, wherein the phase factors are binary phase factors.

5. The method according to claim 1, further including detecting the inversion sequence.

6. The method according to claim 5, further including computing a test statistic for each of the plurality of clusters to determine the inversion sequence.

7. The method according to claim 5, further including quantizing the test statistics.

8. The method according to claim 7, further including decoding the inversion sequence to a nearest Walsh sequence.

9. The method according to claim 7, further including decoding the inversion sequence to a nearest Walsh sequence based upon Hamming distance.

10. The method according to claim 7, further including decoding the inversion sequence to a nearest Walsh sequence based upon Euclidean distance.

11. A method of embedding PAP-reducing inversion sequences onto transmitted data, comprising:

determining an initial PAP value for a block of symbols;

partitioning the block of symbols into a predetermined number of clusters;

selecting a respective phase factor for each of the clusters so as to form an inversion sequence that reduces a PAP of transmitted data corresponding to the block of symbols; and

embedding the inversion sequence onto the transmitted data by rotating selected tones in each of the clusters based upon a value of the associated phase factor.

12. The method according to claim 11, further including employing an iterative process to determine the phase factors.

13. The method according to claim 11, further including approximating an optimal inversion sequence.

14. The method according to claim 11, further including selecting the inversion sequence from predetermined Walsh sequences.

15. The method according to claim 11, wherein the phase factors are binary.

16. The method according to claim 11, further including rotating every other tone in each cluster having an associated phase factor that rotates the cluster.

17. The method according to claim 11, further including detecting the inversion sequence.

18. The method according to claim 17, further including computing a test statistic for each cluster.

19. The method according to claim 18, further including selecting the inversion sequence from a nearest one of predetermined Walsh sequences.